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LISTS OF SPECIES

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Squamate reptiles from Mauá Hydroelectric Power Plant, state of Paraná, southern Brazil

Gilberto Alves de Souza Filho[1*] and **Fernanda Stender de Oliveira**[2]

1 Hori Consultoria Ambiental, Rua Coronel Temístocles de Souza Brasil, 311, CEP 82.520-210, Curitiba, PR, Brazil
2 Sociedade da Água Serviços Ambientais e Engenharia, Rua Desembargador Hugo Simas, 1231, Sala 02, CEP 80.520-250, Curitiba, PR, Brazil
* Corresponding author. E-mail: gilbertoasfilho@yahoo.com.br

Abstract: The reptile fauna of some localities in Paraná is still poorly known. Most surveys were conducted in the central-north, central-south, and eastern regions of the state. Herein, we present a list of squamate reptiles from the Mauá Hydroelectric Power Plant along the Tibagi River, in the central-east region of Paraná. Samplings occurred from March 2010 to April 2015. We recorded 34 species: 24 snakes, eight lizards, and two amphisbaenians. Our work adds new knowledge about the reptilian fauna of the central-east region of Paraná.

Key words: Reptilia, Squamata, Atlantic Forest biome, central-east Paraná, Tibagi River

INTRODUCTION

Our knowledge of the reptile fauna in the state of Paraná is fragmentary. The main studies include lists of species collected in the past decades (Boettger 1906; Bérnils and Moura-Leite 1990, 2010), new records for the state (Moura-Leite et al. 1996), studies on geographic distribution (D'Amato 1991; Ribas and Monteiro Filho 2002; Bérnils et al. 2007), and lists of endangered species (Morato et al. 1995; Bérnils et al. 2004). Currently, 154 species of reptiles are recorded in Paraná, including nine chelonians, one crocodilian, eight amphisbaenians, 25 lizards, and 111 snakes (Bérnils et al. 2007). Despite the significant species richness, lists of species for many localities are still scarce and restricted to Londrina (Bernarde and Machado 2002, 2006), São José dos Pinhais (Oliveira and Oliveira 2014), and the Complexo Energético Fundão-Santa Clara in the central-south region of the state (Souza-Filho et al. 2015).

Here, we present a list of species recorded during the monitoring of reptile fauna in the area under the influence of the Mauá Hydroelectric Power Plant, in central-east Paraná. In addition to the field inventory, we also included museum records from faunal rescues previously carried out in the same place.

MATERIALS AND METHODS

Study site

The Mauá Hydroelectric Power Plant (UHE Mauá) is located in the Tibagi River, between Telêmaco Borba and Ortigueira, in the middle Tibagi River, central-east Paraná (24°07′37″ S, 050°42′12″ W; datum = WGS84; Figure 1). The region is situated in the Atlantic Forest biome, in an ecotone between the Araucaria Forest and Semideciduous Atlantic Forest (Roderjan et al. 2002; IBGE 2004). The local climate is Köppen's Cfa, subtropical temperate, without a dry season and with few frosts (Cigolini et al. 2001).

Sampling

The fieldwork was carried out from March 2010 to April 2015, totaling 35 samplings, each lasting five days. We sampled 12 areas mostly on the right bank of the river, using the following methods (Figure 1):

1. Visual encounter survey (Guyer and Donnelly 2012): search for specimens in all potential microenvironments (leaf litter, under fallen logs, under rocks, holes in the ground, and trees) done by two people during eight hours (including day and night), five days in each sampling period, totaling a sampling effort of 1,400 h/man.
2. Pitfall traps (Fisher and Rochester 2012): we built 48 fences of pitfall traps within forest fragments, of which 36 were used during 27 sampling periods, and 12 for eight sampling periods. Each trap was composed of four 60 L plastic buckets, buried 10 m apart, and connected by a fence about 0.8 m high. These traps remained open for five days during each sampling period, being revised every morning. Total sampling effort of pitfall traps was 21,360 buckets/day.
3. Occasional records: specimens recorded alive or dead on roads, as well as obtained by other researchers during the fieldwork.

To complete the list of species, we also used museum records, available in the herpetological collection of the

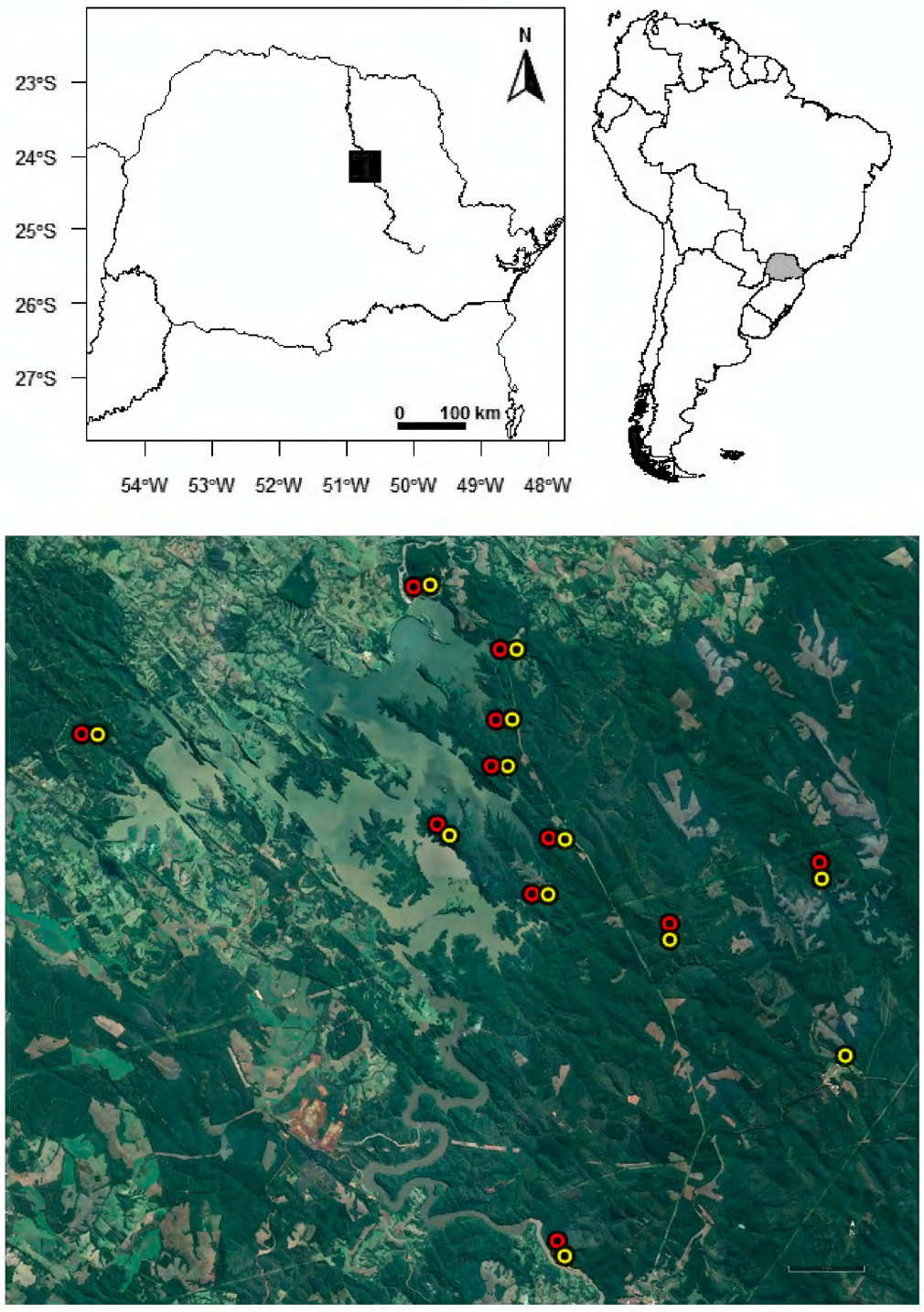

Figure 1. Map showing the location of the Mauá Hydroelectric Power Plant in the Tibagi River, state of Paraná, southern Brazil (square). The image shows the location of the sampling areas (dots) in the study region. Yellow dots represent areas sampled by visual encounter and red dots represent areas sampled with pitfall traps (image source: Google Earth™ 2015).

Museu de História Natural Capão da Imbuia (MHNCI) in Curitiba, Paraná, from faunal rescues carried out in the study area (Appendix 1).

Species were identified based on Peters and Donoso-Barros (1970), Peters and Orejas-Miranda (1970), Jackson (1978), Avila-Pires (1995), Di-Bernardo (1996), and Silva Jr. and Sites Jr. (1999). Taxonomy follows Uetz and Hosek (2015).

Voucher specimens were collected (collection permit IBAMA/PR number 004/2010, IAP 36492 and IAP 36517), killed by cooling, fixed in 10% formalin, preserved in 70% ethanol, and deposited in the herpetological collection of the MHNCI (Appendix 1).

Data analysis

To evaluate sampling effectiveness to estimate species richness, we constructed a species accumulation curve, with 10,000 randomizations of the original field samples, using the EstimateS 9.1.0 software (Colwell 2013). We compared the similarity in species composition of the study site with other communities of Araucaria Forest and Semideciduous Atlantic Forest of southern Brazil using a hierarchical cluster analysis with Jaccard's similarity coefficient, in Past version 3.09 (Hammer et al. 2001).

RESULTS

We recorded 34 species, including 24 snakes: Colubridae ($n=3$), Dipsadidae (15), Elapidae (2), Viperidae (3), and Anomalepididae (1); eight lizards: Leiosauridae (2), Gekkonidae (1), Gymnophthalmidae (1), Teiidae (1), Scincidae (2), and Diploglossidae (1); and two Amphisbaenidae (Figures 2 and 3; Table 1). Most species were recorded in forested habitats using visual encounter survey. The exotic *Hemidactylus mabouia* was associated to human habitations, but not in natural habitats.

The species accumulation curve has not stabilized, indicating that more species may occur in the study area (Figure 4). This was confirmed with the examination of scientific collection. Species composition of the study site is more similar to Londrina (Figure 5), while those of the farthest area: Aparados da Serra National Park, was least similar.

DISCUSSION

The species richness found represent 24% of the 144 species of squamate reptiles known to the state of Paraná (Bérnils et al. 2007) and 17% of the 201 recorded species to the Atlantic Forest (Rodrigues 2005). The local community is composed of species widely distributed along the Atlantic Forest domain, occurring in several Brazilian biomes. Except for *Enyalius perditus* and *Echinanthera cephalostriata* that are endemic species of the Atlantic Forest biome (IBGE 2004; Bérnils 2009; Rodrigues et al. 2014).

The majority of the species occur in forested environments, many of them are typical of this habitat, such as *Bothrops jararaca*, *Bothrops jararacussu*, *Chironius bicarinatus*, *C. exoletus*, *Clelia plumbea*, *Dipsas alternans*, *Echinanthera cephalostriata*, *E. cyanopleura*, *Enyalius perditus*, *Erythrolamprus aesculapii*, *Micrurus corallinus*, *Ophiodes fragilis*, *Oxyrhopus clathratus*, *Philodryas olfersii*, *Spilotes pullatus*, *Tomodon dorsatum*, *Tropidodryas striaticeps*, *Urostrophus vautieri* and *Xenodon neuwiedii* (Marques et al. 2001; Bernarde and Machado 2002; Bérnils et al. 2007). The occurrence pattern of these species in the area is associated with the Araucaria Forest and Semideciduous Atlantic Forest.

The species richness of areas of Araucaria Forest and Semideciduous Atlantic Forest of southern Brazil ranges from 20 to 37 species (Bernarde and Machado 2002; Deiques et al. 2007; Hartmann and Giasson 2008; Kunz 2012; Souza-Filho et al. 2015). However, several factors, such as the size of the sampling areas, sampling methodologies and effort may directly influence the species richness.

Despite the vast areas covered by the Atlantic Forest in

Figure 2. Some species of squamate reptiles recorded at Mauá Hydroelectric Power Plant, state of Paraná, southern Brazil: **A**) *Enyalius perditus*; **B**) *Hemidactylus mabouia*; **C**) *Cercosaura schreibersii*; **D**) *Salvator merianae*; **E**) *Aspronema dorsivittatum*; **F**) *Notomabuya frenata*; **G**) *Ophiodes fragilis*; **H**) *Spilotes pullatus*; **I**) *Echinanthera cyanopleura*; **J**) *Erythrolamprus aesculapii*; **K**) *Philodryas olfersii*; **L**) *Sibynomorphus mikanii*; **M**) *Tomodon dorsatum*; **N**) *Tropidodryas striaticeps*; **O**) *Xenodon merremi*.

southern Brazil, inventories are still scarce in this biome when compared to other regions of the country, such as São Paulo (Sazima and Haddad 1992; Cadle and Greene 1993; Sazima 2001; Marques and Sazima 2004; Dixo and Verdade 2006; Cicchi et al. 2007; Cicchi et al. 2009; Centeno et al. 2008; Condez et al. 2009; Hartmann et al. 2009; Araujo et al. 2010; Forlani et al. 2010). In Paraná, most surveys were conducted in Dense Ombrophilous Forest (Oliveira and Oliveira 2014), in an ecotone between the Araucaria Forest and Steppe (Souza-Filho et al. 2015), and in the Semideciduous Atlantic Forest (Bernarde and Machado 2002, 2006). Inventories in new areas frequently reveal new species, improving the knowledge about biodiversity and conservation policies

Figure 3. Some species of squamate reptiles recorded at Mauá Hydroelectric Power Plant, state of Paraná, southern Brazil: **A**) *Xenodon neuwiedii*; **B**) *Micrurus altirostris*; **C**) *Micrurus corallinus*; **D**) *Bothrops jararaca*; **E**) *Crotalus durissus*; **F**) *Liotyphlops beui*.

Table 1. Squamate reptiles recorded at Mauá Hydroelectric Power Plant, central–east region of Paraná state, showing the locality, the habitat and the record type of the species found in the region. Locality: OR = Ortigueira; TB = Telêmaco Borba. Habitat: FE = forest edge; FO = forest; HH = human habitation; RO = road. Record type: MR = museum record; OC = occasional record; PT = pitfall traps; VE = visual encounter.

Taxa	Locality	Habitat	Record type
Leiosauridae			
Enyalius perditus Jackson, 1978	OR; TB	FO; RO	MR; OC; PT; VE
Urostrophus vautieri Duméril & Bibron, 1837	TB	–	MR
Gekkonidae			
Hemidactylus mabouia (Moreau de Jonnès, 1818)	TB	HH	MR; VE
Gymnophthalmidae			
Cercosaura schreibersii Wiegmann, 1834	TB	FE; FO	PT; VE
Teiidae			
Salvator merianae (Duméril & Bibron, 1839)	OR; TB	FE; FO; RO	MR; OC; PT; VE
Scincidae			
Aspronema dorsivittatum (Cope, 1862)	TB	FE; FO	PT; VE
Notomabuya frenata (Cope, 1862)	TB	FO	MR; PT
Diploglossidae			
Ophiodes fragilis (Raddi, 1826)	TB	FE; FO	PT; VE
Amphisbaenidae			
Amphisbaena prunicolor (Cope, 1885)	–	–	MR
Amphisbaena trachura Cope, 1885	TB	–	MR
Colubridae			
Chironius bicarinatus (Wied, 1820)	–	–	MR
Chironius exoletus (Linnaeus, 1758)	–	–	MR
Spilotes pullatus Linnaeus, 1758	TB	RO	MR; OR
Dipsadidae			
Clelia plumbea (Wied, 1820)	–	–	MR
Dipsas alternans (Fischer, 1885)	–	–	MR
Echinanthera cephalostriata Di-Bernardo, 1996	TB	FO	MR; PT
Echinanthera cyanopleura (Cope, 1885)	TB	FO; RO	MR; OC; VE
Erythrolamprus aesculapii (Linnaeus, 1758)	TB	FO; RO	MR; OC; VE
Erythrolamprus poecilogyrus (Wied-Neuwied, 1825)	–	–	MR
Oxyrhopus clathratus Duméril, Bibron & Duméril, 1854	–	–	MR
Philodryas olfersii (Lichtenstein, 1823)	TB	FE	MR; VE
Philodryas patagoniensis (Girard, 1858)	–	–	MR
Sibynomorphus mikanii (Schlegel, 1837)	TB	FE; FO	MR; VE
Thamnodynastes strigatus (Günther, 1858)	–	–	MR
Tomodon dorsatum Duméril, Bibron & Duméril, 1854	TB	FO	MR; OC; PT; VE
Tropidodryas striaticeps (COPE, 1870)	TB	FO	MR; VE
Xenodon merremi (Wagler, 1824)	TB	RO	MR; OC
Xenodon neuwiedii Günther, 1863	TB	FO; RO	MR; OC; PT; VE
Elapidae			
Micrurus altirostris (Cope, 1860)	TB	FE; FO	MR; PT; VE
Micrurus corallinus (Merrem, 1820)	OR; TB	FO; RO	MR; OC; PT; VE
Viperidae			
Bothrops jararaca (Wied, 1824)	OR; TB	FE; FO; RO	MR; OC; PT; VE
Bothrops jararacussu Lacerda, 1884	TB	–	MR
Crotalus durissus Linnaeus, 1758	TB	FE; RO	MR; OC; VE
Anomalepididae			
Liotyphlops beui (Amaral, 1924)	TB	FE	MR; VE

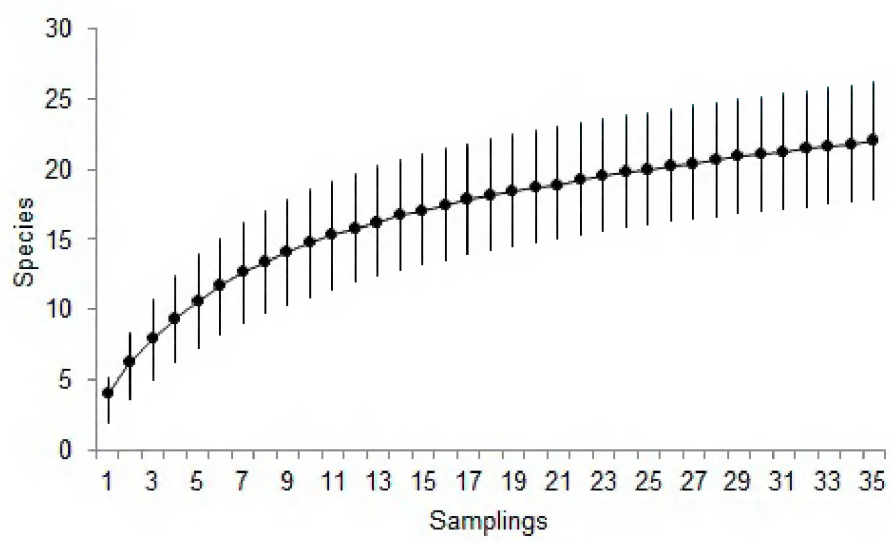

Figure 4. Species accumulation curve of the squamate reptiles recorded at Mauá Hydroelectric Power Plant, Paraná, southern Brazil. The vertical bars indicate the upper and lower limits of the 95% confidence interval.

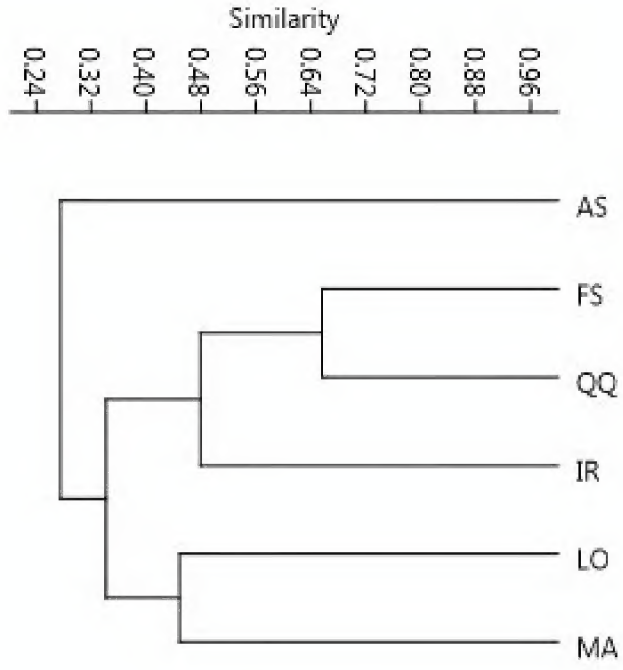

Figure 5. Dendrogram of cluster analysis using Jaccard's similarity index between reptile communities of Araucaria Forest and Semideciduous Forest of the Atlantic Forest biome of southern Brazil: MA - Mauá Hydroeletric Power Plant/Paraná (present study); FS - Complexo Energético Fundão-Santa Clara/Paraná (Souza-Filho et al. 2015); LO - Londrina/Paraná (Bernarde and Machado 2002); AP - Aparados da Serra National Park/Santa Catarina and Rio Grande do Sul (Deiques et al. 2007); IR - Irani River/Santa Catarina (Kunz 2012); QQ - Quebra Queixo Hydroeletric Power Plant/Santa Catarina (Hartmann and Giasson 2008).

(Rodrigues 2005).

No recorded species is threatened of extinction either in regional (Bérnils et al. 2004), national (MMA 2014), or international (IUCN 2015) level. This work improved out knowledge of the reptilian fauna of southern Brazil, especially of the central-east region of Paraná. We also emphasize that more inventories should be carried out in the state.

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Appendix 1. Collection number of squamate reptiles from Mauá Hydroelectric Power Plant housed in the herpetological collection of the Museu de História Natural Capão da Imbuia (MHNCI).

Leiosauridae: *Enyalius perditus* (Telêmaco Borba: MHNCI 12953, 12955, 12956, 12960, 12961, 12966, 16414), *Urostrophus vautieri* (Telêmaco Borba: MHNCI 12951, 12952, 12954, 12971); **Gekkonidae:** *Hemidactylus mabouia* (Telêmaco Borba: MHNCI 12959); **Gymnophthalmidae:** *Cercosaura schreibersii* (Telêmaco Borba: MHNCI 13776); **Teiidae:** *Salvator merianae* (Telêmaco Borba: MHNCI 12964, 12965); **Scincidae:** *Notomabuya frenata* (Telêmaco Borba: MHNCI 12957, 12958, 12963); **Diploglossidae:** *Ophiodes fragilis* (Telêmaco Borba: MHNCI 13779); **Amphisbaenidae:** *Amphisbaena prunicolor* (without specific locality: MHNCI 16083, 16088, 16108, 16118, 16291), *Amphisbaena trachura* (Telêmaco Borba: MHNCI 12949; without specific locality: MHNCI 16072, 16073, 16100, 16110, 16115); **Colubridae:** *Chironius bicarinatus* (without specific locality: MHNCI 16156, 16173), *Chironius exoletus* (without specific locality: MHNCI 16150), *Spilotes pullatus* (Telêmaco Borba: MHNCI 12932); **Dipsadidae:** *Clelia plumbea* (without specific locality: MHNCI 16163), *Dipsas alternans* (without specific locality: MHNCI 15856, 16175), *Echinanthera cephalostriata* (without specific locality: MHNCI 16170, 16172, 16203), *Echinanthera cyanopleura* (Telêmaco Borba: MHNCI 13773; without specific locality: MHNCI 15851, 16171, 16192), *Erythrolamprus aesculapii* (Telêmaco Borba: MHNCI 13775, 16418; without specific locality: MHNCI: 16039, 16040), *Erythrolamprus poecilogyrus* (without specific locality: MHNCI 15853, 15939, 15942, 15948, 16194, 16210), *Oxyrhopus clathratus* (without specific locality: MHNCI 16161, 16188, 16198, 16205, 16207), *Philodryas olfersii* (Telêmaco Borba: MHNCI 12946; without specific locality: MHNCI 15888, 15941, 16200, 16201), *Philodryas patagoniensis* (without specific locality: MHNCI 15952), *Sibynomorphus mikanii* (Telêmaco Borba: MHNCI 12935, 12937, 12942; without specific locality: MHNCI 15857, 15936, 15937, 15938, 15940, 15943, 15947, 16151), *Thamnodynastes strigatus* (without specific locality: MHNCI 15944, 16199), *Tomodon dorsatum* (Telêmaco Borba: MHNCI 12977), *Tropidodryas striaticeps* (Telêmaco Borba: MHNCI 12934, 12947; without specific locality: MHNCI 15953, 16154, 16160, 16185, 16186, 16193), *Xenodon merremi* (Telêmaco Borba: MHNCI 13778; without specific locality: MHNCI 15950, 15954), *Xenodon neuwiedii* (Telêmaco Borba: MHNCI 12930, 13777; without specific locality: MHNCI 15852, 15877, 15892, 15951, 16038); **Elapidae:** *Micrurus altirostris* (without specific locality: MHNCI 16045, 16046), *Micrurus corallinus* (Ortigueira: MHNCI 12931; Telêmaco Borba: MHNCI 12928, 12941, 16416; without specific locality: MHNCI 15878, 15886, 15921, 16042); **Viperidae:** *Bothrops jararaca* (Telêmaco Borba: MHNCI 12929, 12936, 12939, 12943, 12944, 12948, 12970, 16415), *Bothrops jararacussu* (Telêmaco Borba: MHNCI 12938), *Crotalus durissus* (Telêmaco Borba: MHNCI 12950, 13774, 16417); **Anomalepididae:** *Liotyphlops beui* (Telêmaco Borba: MHNCI 12940, 12945, 12962).